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SPACE COMMUNICATION AND THE MASS MEDIA. A UNESCO REPORT ON THE OCCASION OF THE 1963 SPACE COMMUNICATIONS CONFERENCE.
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THIS REPORT DEFINES AND ANALYZES POTENTIAL ASPECTS OF WORLDWIDE COMMUNICATION BY SATELLITE, LISTS TECHNICAL PROBLEMS, AND SUGGESTS USES OF SPACE COMMUNICATION TO PROMOTE EDUCATION, CULTURAL EXCHANGE, AND INFORMATION FLOW. IT IS AVAILABLE FOR $0.50 FROM NATIONAL DISTRIBUTORS OF UNESCO PUBLICATIONS, OR FROM UNESCO, PLACE DE FONTENDOY, PARIS-7E, FRANCE. (LH)

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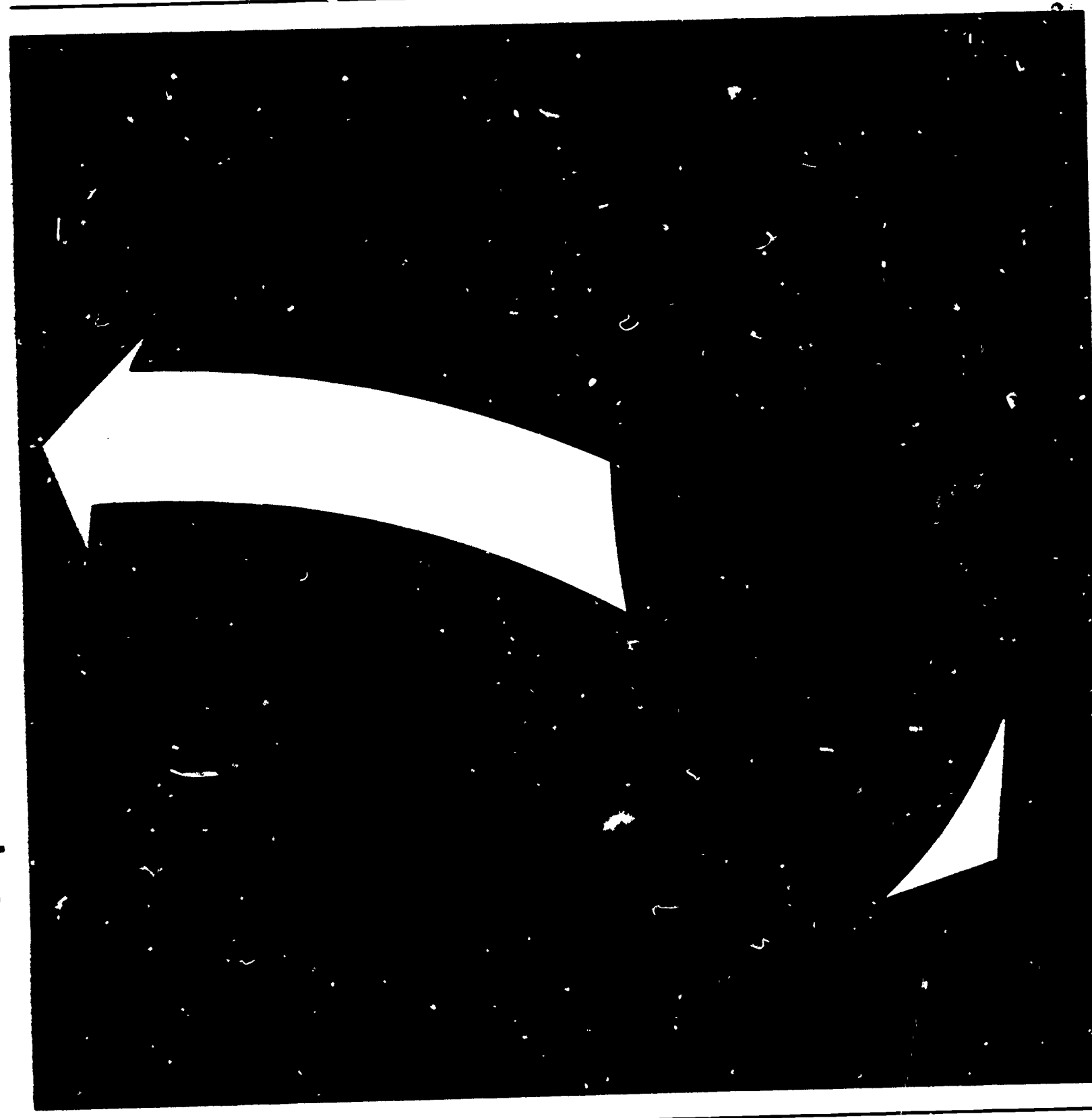
Space Communication and the Mass Media



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Space Communication and the Mass Media

A Unesco report on the
occasion of the 1963
Space Communications Conference

Unesco

FOREWORD

This report attempts to assess the prospects offered by space communication for enhancing the range and scope of the press, radio broadcasting and television. Although such an assessment at the present incipient and rapidly developing phase of space communication is bound to be highly speculative and transitory in character, it might nevertheless be of interest at this time to those concerned with the use of this new telecommunication technique by the mass media.

The origin of the report was a decision of the General Conference of Unesco in December 1962 authorizing a study of "the consequences which the use of new techniques of communication on a world scale, by means of artificial satellites", is likely to have upon the achievement of Unesco's essential objectives. The Organization was also to aid "the international bodies concerned with these questions, so that the interests of education, science, culture and mass communication may, in the handling of these problems, be given the special attention which is their due".

The report was prepared on the occasion of the Extraordinary Administrative Radio Conference on Space Communications, convened by the International Telecommunication Union at Geneva in October 1963. Among other things, it was designed to indicate, from the point of view of the mass media, the long-term implications of the allocation of frequencies for space communication services.

The report seeks at the outset to define the features of space communication within the pattern of communication as a whole. It then deals with technical problems affecting the development and operation of space communication services and, finally, with the possible use of space communication to promote the flow of information, the spread of education and cultural exchange, The principal points emerging from the report are set forth in a concluding page.

TABLE OF CONTENTS

CHAPTER I

FEATURES OF SPACE COMMUNICATION

A new era in human communication opened in mid-1962 when, for the first time, press dispatches, news photos, radio bulletins and live television programmes were relayed between continents by means of artificial satellites in outer space. Although rapid long-distance communication through more conventional channels, such as cable and radio, have become a general feature of our time, space communication opens up significant new possibilities for the future in which distances and other natural barriers will no longer impede contact among peoples anywhere on the globe.

Satellite transmissions thus far have been of an experimental character, and there are many problems to be solved before the technique comes into use on a regular or economically viable basis. However, experience shows that the gap between the experimental and practical stages of any demonstrably useful invention, particularly in the communication field, tends to be shorter and shorter as time goes on. It is not too early, therefore, even at the present incipient phase of space communication, to examine the prospects offered by this new technological advance.

Artificial satellites constitute a powerful instrument for long-distance communication, making possible high speed transmission in greater volume than can be achieved by other means now available. To the advantages of speed and volume are added that of world-wide coverage; at a sufficient altitude, a single satellite would be accessible at any given moment to ground stations throughout nearly one-third of the globe. This means that a space communication system could make it possible for important events to be seen and heard simultaneously by greater audiences than ever before - as was dramatically demonstrated in September 1962 by the simultaneous television broadcast, on both sides of the Atlantic, of ceremonies held in New York, Paris and Uppsala (Sweden) in memory of Dag Hammarskjold on the first anniversary of his death. Satellites might also, in time, provide the means of relaying programmes direct to individual radio and television receivers, opening up vast new possibilities particularly in regions where the construction of transmitting stations is prohibited by sparsity of population or lack of economic resources.

Because of the versatility and flexibility of the services which they can provide, satellites seem to meet the increasing need for long-distance communication facilities of all kinds. At present, most of the world's long distance communication channels are being used to capacity. According to one expert estimate, moreover, communication capacity on routes linking major regions of the world, including the developing areas, would need to increase fivefold by 1970 in order to keep up with the demand.(7) Higher capacity ocean cables are in prospect and will improve the service on high traffic volume routes. Cables cannot, however, serve as wide a variety of terminals effectively, as can satellites. Space communication may therefore provide a useful supplement to conventional channels. Moreover, some experts anticipate that when it has reached an advanced stage of development, space communication could offer services at relatively lower cost than those now available.

For the developing countries particularly, satellites could generally provide greater security and flexibility, both by making alternative routes available and if appropriate satellites were used by assuring direct access to areas which have only limited links by cable or radio with the outside world. Many of the plans for space communication now under study envisage satellites which would be used interchangeably or simultaneously for television and other purposes.

The problems involved in developing a comprehensive satellite system are so complex and diverse that it is still too early to predict what type of system will be adopted, and when. Nevertheless, a considerable body of opinion foresees three phases of satellite development by the end of this century. In the first phase, a global system of low-powered satellites would be established, serving ground stations which in general would be of a high-powered, sophisticated type, linked to conventional distribution networks. This sytem would provide telephone and telegraph services of the same quality as the best now available, and facilities for the relay of sound and visual broadcasting. In the second phase, a system of high-powered satellites and lower-powered, less sophisticated ground stations would furnish direct communications between cities and perhaps direct broadcasts to homes. In the third phase, a comprehensive system of manned satellites would link cities, countries and continents directly.(8)

EVOLUTION OF TELECOMMUNICATION

While the future of space communications presents a great many unknowns, the past history of telecommunication suggests that the interaction with

the mass media will be swift. Each technical advance in this field has spurred the information process which has in turn acted as a catalyst to technological progress.

If the invention of mechanical printing marked the advent of mass communication, the introduction of the electric telegraph first made possible the speedy transmission of messages over long distances. Less than 20 years elapsed between the time when the electric telegraph was first conceived and when it came into general use. By the 1850's, large areas of Europe and North America were covered with a network of telegraph lines, spreading news rapidly, and providing speedy communication for governmental, commercial and private users.

The effect of the telegraph on newspaper publishing was nothing short of revolutionary. The printing press had made the newspaper possible, but it was the telegraph that gave the newspaper its contemporary form. Before telegraphy came into use, news from distant points could not be published until long after the event; if news of an event aroused public opinion, it was usually too late for such opinion to make itself effectively felt. News sent by telegraph, however, could be published in a matter of hours.

Since the telegraph first made rapid long-distance contact possible, major advances in communication techniques have been measured, at most, in decades. The telephone followed the telegraph by less than 40 years. Twenty-five years later came wireless telegraphy, which could provide instantaneous communication between points not linked by telegraph lines or between moving points, such as ships at sea. This new invention had hardly been revealed to the world when experts began to apply its techniques to the telephone.

On the heels of wireless telegraphy came broadcasting. Great as was the impact of the telegraph, telephone and wireless on social, economic and even political life, none of them provided a new means of direct communication to large numbers of people. In other words, they did not constitute new mass communication media, even though they did contribute immensely to the expansion of the one medium of mass communication then in existence: the press. Broadcasting was a new medium in itself, and one that was destined to reach millions of people who could not have read newspapers even if they had had any.

About the same time as inventors were first developing the wireless transmission of signals and sounds, other pioneers were working on new techniques involving images. By the first years of the Twentieth century they had learned how to present a rapid succession of photographs on a screen to give the illusion of motion, and the cinema soon became the third great medium of mass communication. Meanwhile, experiments were being made with the rapid transmission of images over long distances - first by telegraph wire, then by radio. The next step was an effort to use the radio for transmitting moving pictures. Although the problems here were quite different from those involved in transmitting single images, they were solved in their turn, and moving pictures entered the home through television. Television had just been introduced to the public when its further development was postponed by the Second World War. Once the war was over, however, its popularity grew rapidly, and it was recognized as the fourth - and most versatile - of the great mass communication media.

In the century and a quarter since the telegraph was invented, the history of telecommunications has been one of extremely rapid advance. Clearly, new inventions in the field would not have been developed so swiftly if the practical need for them had not been evident - as in the case of the telegraph, for example or if they had not answered some psychological need - as radio broadcasting, then television, did by providing entertainment to millions who, as the working day shortened, were gaining leisure they had never enjoyed before.

In the same pattern, outer space communication makes its appearance at a time when there is an acute need for increased telecommunication facilities. Artificial satellites do not provide a new medium of communication; they constitute a technical innovation which permits the extension of existing means - as the power-driven rotary press speeded up the printing of newspapers and made very large editions possible, or as the audion improved radio transmission and reception and thus paved the way for organized broadcasting. The experiments already made have shown that satellites can be used to relay every type of information commonly transmitted by telegraphy or telephone, radio or television - if not yet with equal efficiency in every field. Thus, space communication brings a new dimension to all the great media of mass communication, offering them a potential extension of range and scope which could permit them to play a greater rôle than ever before.

USES FOR INFORMATION AND EDUCATION

The possible applications of space communication through the mass media are described in Chapter III. However, it may be useful here to consider the requirements in the fields of information and education which space communication may in time help to meet.

In the information field, the impact of this striking new departure is all the more unpredictable since it comes at a time when the media of mass communication are already changing rapidly. The supremacy of the printed word has been challenged first by the spoken word transmitted by radio, and then by the image transmitted on television. As they developed and perfected their techniques, radio broadcasting and television have vied increasingly with the press, at least as the initial purveyor of news. Today, the individual

often listens to the news, or sees it, before he reads it.

It is clear that the instantaneous, world-wide transmission of a greater volume of words and images through space communication will give still greater range and scope to broadcasting and particularly to television. But it can also serve the press in the immediate future for the collection of news and may, in the long run, be applicable for distribution as well by providing facsimile channels for the simultaneous reproduction of a newspaper at widely separated cities and its direct transmission into homes. By providing new dimensions to the press and to sound and visual broadcasting alike, space communication is bound to accelerate the already changing pattern of each of the media and their relation to each other in the information process.

Whatever the medium with which it is associated, space communication would seem to respond to at least three requirements of information in modern society. First, its speed of transmission keeps pace with the quickening tempo of world events. Second, its range allows for dissemination to and from the far corners of the earth, which are becoming increasingly the focus of crisis and change. Third, its volume of transmission is consonant with the growing complexity of news events and the need for greater background about them. In all three respects, space communication holds great potentialities as a means of permitting the mass media to create a more informed public opinion.

In carrying out its most immediate rôle as a stimulant to the flow of news and other information, space communication thus serves as an auxiliary to education in its broadest sense. As far as formal education is concerned, greater uncertainty prevails as to the place of this new technique. For the foreseeable future, its utility will no doubt be weighed against the cost factor and the possibility of alternative means of adequately swift communication. In the realm of speculation is the long-term prospect of direct broadcasting from satellites and the new avenues that would open for the transmission of educational programmes to television screens in schools, homes and community groups.

The use of new techniques of communication for educational purposes was examined at a broadly representative meeting of experts on this subject, convened by Unesco in 1962. The experts noted that "the resources which modern technology makes available to education may be employed both to improve the teaching process and to bring instruction within the reach of a continually increasing number of children and adults". They added that "among these resources, the potentialities of sound and visual broadcasting, far from being fully explored, are proving greater day by day, as seems to be indicated by plans for relaying radio and television through the use of satellites". Commenting on the future prospects of "the world-wide use of sound and picture messages", the report of the meeting observes: "Without wishing to express a final opinion at this stage concerning the practical use of satellites, and without minimizing the technical, legal, linguistic and other educational problems that would be involved, the members of the meeting drew Unesco's attention to the need for considering at the appropriate time the setting aside of wave-lengths for educational programmes."(9)

These same considerations have engaged the attention of outstanding individual experts in the mass media field. An expert from France has observed that the advent of space communication was causing educators to consider whether the systematic dissemination of information over vast international zones might not lead to the development of new educational methods. In particular, he added, the possibility of diffusing educational programmes over broad areas might facilitate the wider use of simplified educational services such as a series of teleclubs directed by a single teacher instead of expensive traditional systems.(10)

Another specialist of the mass media, from the United States of America, has remarked that "a satellite in orbit will perhaps be able to transmit an educational programme to an entire nation". Space communication, he added, could thus "contribute strikingly to the information, the education and the binding together of the people of a nation".(11)

DEVELOPING COUNTRIES

For the developing countries, in particular, space communication poses perplexing questions. As they expand their conventional telecommunication services, this new technique may well permit them to bypass some of the intermediate steps which have hitherto been necessary in establishing a communication system and thus to have at their disposal, within a relatively short space of time, more plentiful and more versatile communications facilities than would have seemed possible even a decade ago. But it also presents a number of imponderables ranging from the practical one of cost to the more far-reaching problem of determining the effect on traditional cultures of these new avenues of communication.

However, any assessment made by the developing countries is likely to take into account primarily the value of this new technique, in combination with the mass media, as a means of coping with the stupendous educational problems they face. Some 60 per cent of adult persons in these regions are illiterate, while the school population is increasing with explosive speed. Facilities for formal education range from barely adequate to extremely inadequate and at the secondary and higher levels are largely concentrated in urban areas. There is good reason to believe that large-scale use of the mass media would materially assist in overcoming illiteracy and spreading educational opportunities.

Yet even the mass media are in critically short supply: nearly 70 per cent of the world's people,

living in over 100 countries in Africa, Asia and Latin America, have less than the minimum facilities in the fields of press, radio and film, and only a few have been able as yet to initiate television services. Hence, the attitude toward space communication in those regions will no doubt depend on the degree to which its judicious introduction, along with the expansion of conventional telecommunication, may permit a quickening pace of educational and in turn economic and social progress.

Addressing himself to this question in a recent speech to the Economic Commission for Africa, the Secretary-General of the International Telecommunication Union observed that the developing countries should aim to employ "the most modern telecommunication techniques to link with international traffic centres and large national main traffic lines" while at the same time using "more orthodox and simple techniques... to reach areas which are still in the early stages of development". He envisaged the use of satellites for long-distance links, while telephone lines and cables, as well as simple radio transmitters and receivers, would be used simultaneously to reach small towns and villages in the interior of a country. "Regular sound broadcasting and television", he added, "will support the educational process. Low-cost transistorized equipment will overcome economic barriers and the lack of power supplies". He concluded that "it is essential that all the areas of the world should be able to participate in the benefits of this latest achievement of science at the earliest possible moment".(12)

PROMOTION OF INTERNATIONAL UNDERSTANDING

If it is a truism to say that the mass media are merely instruments to be used for good or for ill as men wish, this is all the more so when applied to space communication which is no more than a transmission technique. Yet their technique is so revolutionary an innovation that it has prompted the highest authorities to assess its implications for the promotion of international understanding.

Following the successful launching of the first communications satellites, the General Assembly of the United Nations at its 17th session in December 1962 adopted a resolution recording the view that "communication by satellite offers great benefits to mankind, as it will permit the expansion of radio, telephone and television transmissions, thus facilitating contact among the peoples of the world".(13)

Similar convictions have been voiced by leaders in a number of countries engaged in the development of space communication. As early as July 1961, the President of the United States of America, in a statement on communications satellite policy, declared that "science and technology have progressed to such a degree that communication through the use of space satellites has become possible". All nations, he suggested, might "participate in a communication satellite system, in the interest of world peace and closer brotherhood among peoples throughout the world".(14)

A parallel concern for the effective use of space communication was evinced by the Chairman of the Council of Ministers of the Union of Soviet Socialist Republics, in an exchange of messages in March 1962 with the President of the United States of America on the exploration and use of outer space. The Chairman stated that the use of space satellites for creating international communication networks "can lead to a considerable improvement of means of communication and television on the earth. People will get reliable means of communication and new unprecedented possibilities will arise for expanding contacts between the peoples."(15)

The importance of space communications as an aid to international understanding was also emphasized by the President of France in a speech made during a visit in October 1962 to the French ground station at Pleumeur Bodou, Brittany. Hailing the transmission of messages through satellites as an "international success", the President declared that space communication "will probably be decisive for relations among men, for their mutual understanding, for their friendship. The day is coming when it will be harder to imagine war, when all men, wherever they may be, will see one another as they are and will understand one another - in other words, will seem like men to one another".(16)

Space communication has also been a growing preoccupation in other countries. The British Postmaster-General, at a conference of the Commonwealth Press Union in June 1962, drew attention to the "great prospects" opened up by the development of space communication services.(17) A satellite communication conference of 11 Commonwealth Governments, held earlier in 1962 recommended international action in developing a world space communication system which would serve as large a number of countries as possible and have maximum flexibility; and, in Europe, the telecommunication administrations of 15 countries have jointly initiated studies on the co-operative development of space communication.

Unesco, for its part, could not remain indifferent to the possibilities offered by space communication to promote international understanding between peoples, as well as other basic aims of the Organization. Hence the General Conference, in the resolution adopted at its twelfth session which inspired the present report, observed that space communication offers "boundless prospects" for advancing Unesco's objectives and expressed the hope that "these new and powerful means of communication will first of all be applied to the achievement of these objectives through fruitful co-operation between the nations."(18)

CHAPTER II

TECHNICAL PROBLEMS

The technical problems affecting the development and use of space communication as a global service are so novel that it is difficult even to identify them, much less to attempt to review them here in any comprehensive fashion. However, it would appear that a few of the main problems, which are dealt with here, concern the provision of physical facilities such as communication satellites and ground stations; the allocation of frequency bands and the assignment of radio frequencies for satellite transmissions; and the day-to-day functioning of a space communication system. Finally, an examination will be made of the rôle of international co-operation in dealing with certain of these issues.

PHYSICAL FACILITIES

Satellites

As of August 1963, experiments had been conducted with active as well as passive satellites. The active satellites were of a low-powered, non-synchronous type orbiting at comparatively low altitudes and capable only of relaying signals from ground transmitters to special ground receiving stations. These satellites required the use at ground stations of mobile antennas, with computer control, to track the satellites as they moved across the sky.

Research was also being conducted in the development of non-synchronous satellites orbiting at medium altitudes (between 6,000 and 12,000 miles) which would give wider transmission range. In addition, experiments were being carried out in the establishment of high altitude "stationary" satellites which orbit at an altitude of 22,000 miles over the equator at a speed synchronized with the rotation of the earth. These initial experiments have had promising results. It was foreseen that a single synchronous satellite would be able to cover a whole region continually, and a system of three satellites, substantially the whole globe. Another expected advantage with synchronous satellites is that ground stations with fixed antennas could be used; these would be simpler and cheaper to construct and would not require arrangements to transfer traffic from one satellite to another as they rose and set.

The current use of low-powered satellites necessitates the employment of ground stations which amplify signals as they are received for relay through domestic networks to individual radio or television receivers. Research is now being conducted into the development of high-powered satellites which would require less sophisticated and therefore less costly ground stations. Study is also in progress on the problem of designing a satellite which could relay signals directly to individual receivers on the ground.

The setting up of a global satellite system raises very considerable financial, administrative and technical problems. It is still too early to foresee what the international configuration of such a system might be, or the precise method in which it might develop.

According to expert opinion, however, it is not likely that a comprehensive system would be established at one time and, without basic change, serve the world for an indefinite period. Rather, as in the case of the cable, radio and other conventional services, a world-wide satellite system would be the product of continuous growth. The first phase of this system might originate with one country or a limited number of countries which are technically developed. But some of the later phases might be provided by other countries in a position to do so.

For the time being, the very high cost of developing a satellite system would appear to put such an activity beyond the resources of all but a few countries acting individually. By way of example, it may be noted that a United States telecommunication corporation was reported as being prepared to invest some $480 million in establishing a system based on 15 non-synchronous, medium altitude satellites in equatorial orbits and 40 in random polar orbits.(19) In the United Kingdom, studies by the telecommunication administration have been directed towards a system employing 12 non-synchronous satellites in equatorial orbits, the estimated capital cost being from 160 million to 190 million pounds sterling ($448 million to $532 million).(20) Meanwhile, a European industrial study group estimates that the capital costs of a system employing 12 non-synchronous satellites would be the equivalent of $336 million, compared to $132 million for a system based on a single synchronous, high altitude satellite.(21)

On the other hand, much could be accomplished through collective action by countries, including those with more limited economic and technical resources. The various phases of developing a world system, possibly with different types of satellites and of orbits, could be planned and implemented so as to provide the best possible global service at the lowest possible cost. Countries

could thus carry on in the tradition of co-operation built up over many years in the field of conventional telecommunication.

Ground stations

A number of countries, while not yet prepared to participate in the construction and launching of satellites, are interested in establishing ground stations to send or receive space transmissions. According to published reports, ground stations had been constructed as of August 1963 in the United States of America, the Union of Soviet Socialist Republics, the United Kingdom, France, Italy and Brazil, and were being set up in the Federal Republic of Germany and in Japan. Several additional countries were planning to establish them.

Many of the developing countries may not find the financial problem of establishing a ground station to be insuperable. The cost of a station may vary from $1 million to $8 million, depending largely on the capacity of the installation, its location and the complexity of its equipment. The cost of linking the station to the domestic communication network is also to be taken into account.

Of particular interest to countries with limited resources is the possibility of developing a low-capacity ground station which would be used with a medium-altitude non-synchronous satellite system. Such a station, handling up to 12 or 24 two-way telephone channels, might be simplified and cheapened in relation to a typical high-capacity station carrying from 60 to 240 channels. The telephone channels could of course also be used for telegraphy, data transmission and other purposes, such as the exchange of broadcasting programmes. No very extensive installations would be required to make the link with domestic networks. Also of interest is the recent development of a movable ground station which travels in a van and three trailers and can be assembled by four men in as little as 16 hours; an experimental station of this type has been set up in Brazil.

As explained earlier, the introduction of synchronous satellites would make possible the use of simplified, cheaper ground stations with fixed antennas. For both synchronous and non-synchronous satellites, the type of modulation can influence the cost and ease with which access to a system may be obtained. Some systems may require complex and expensive auxiliary timing and co-ordination equipment. Also influencing costs are certain characteristics of domestic distribution networks such as, in television, the number of lines and frames and the modulation polarity. Converters may be required to make various national distribution systems compatible.

It may be expected that there will be considerable interest in the means by which ground stations could be shared by neighbouring countries. If a large volume of traffic is to be handled by a single telecommunication administration or operating agency, the administration or agency would be justified in installing its own ground station. However, the expected high capacity of the channels in a satellite system would indicate that a large number of channels could be handled by a single station and that these consolidated facilities would be economically desirable provided other problems can be solved.

For effective use of a ground station, there must be a local distribution network. If such a network extends to the borders of a particular country, it would probably be less costly to link it with the distribution network across the border than to install a new station in the second country. This, of course, would call for close co-operation between the countries concerned. It is also probable that if a country is to avail itself of satellite services at an early stage it would need to do so through shared stations, because of the expense and difficulties likely to be encountered in operating a large number of ground stations.

In countries with heavy traffic loads, consideration of competitive development in techniques may weigh against the consolidation of ground stations. In such cases, it would be desirable to assure that each administration or agency could, if it so desired, own its own station. This provision would admittedly make the communication system more complex at any particular time. Consequently, as the system develops, it would frequently be necessary to decide whether prospective benefits from competitive developments outweigh the immediate benefits obtainable through the joint establishment and ownership of stations. In any system, administrations or agencies will no doubt not wish to forego the right to establish their own station eventually.

FREQUENCIES

The allocation of frequencies is a key element in the development of all space activity. The Administrative Radio Conference convened by the ITU in 1959, while recommending the holding of the 1963 Conference on space communication, itself took steps to allocate frequencies immediately required for space research. The major concern of the 1963 conference will be to allocate frequencies for space communication proper and in fact for all space services.

As already observed, space communication is, technically, an extension of the conventional means of communication. By the same token, the problem of allocating frequencies for space communication may be regarded as an extension of the complex frequency problem encountered in the development of terrestrial radio services during the past 60 years.

The ITU, which over the years has carried out the task of apportioning the spectrum among the various services, has consistently sought to allocate frequencies on the basis of international co-operation. Difficulties arose, however, when no more desirable frequency bands remained to be

allocated and the needs of all services continued to increase. These services have, in fact, expanded so rapidly in scope and variety that taking into account the needs of radiotelegraphy, radiotelephony, aviation, shipping, defence, science and industry, little more than five per cent of total radio spectrum space has been available for sound broadcasting and television. Thus, by World War II, interference had become common throughout the frequency spectrum. The result was to impair the effectiveness of broadcasting, particularly in the high-frequency bands used for long-distance transmissions.

The need for international co-operation to assure rational and effective use of the radio spectrum has been demonstrated by the number of international conferences convened to examine frequency problems since 1945. The ITU's first post-war Plenipotentiary Conference and its concurrent administrative conferences, held at Atlantic City in 1947, aimed at dealing with the problem of frequency allocation systematically on a world-wide basis. An extended table of frequency allocations was prepared and revised bands of frequencies were allocated for the various radio services.

To implement the new allocation table and deal with other frequency problems, over a dozen world and regional conferences were held during the period 1948-1952. In addition, the International Frequency Registration Board (IFRB) was established, under a decision of the 1947 Plenipotentiary Conference, to assist in reducing any interference that new frequency changes might cause to stations already in operation. The latest general meeting to deal with frequency problems was the Administrative Radio Conference of 1959.

Much, however, remains to be done to secure general agreement on the allocation of frequencies. A persistent problem is that the total frequency requirements submitted by individual countries have greatly exceeded the available spectrum space. In addition, many countries, when considering recommendations for a reduction of their demands, concluded that they themselves would have to be the judge of their requirements.

Promotion of the effective use of frequencies for broadcasting, it may be noted, has preoccupied not only the ITU but also Unesco as part of its work to further the free flow of information through the media of mass communication. In a message to the ITU's Plenipotentiary Conference in 1947, the Director-General of Unesco urged that frequencies for international broadcasting be allocated in a manner which would give all nations and diverse cultures adequate facilities for expression. This same view was voiced by Unesco at subsequent frequency conferences convened by the ITU. In addition, the Organization examined the problem of interference to domestic broadcasts in many countries as a result of overcrowding in the low and medium frequency bands. The Radio Conference of 1959 adopted a recommendation, inspired by Unesco, that countries might seek to overcome this problem by using frequency modulation broadcasting on very high frequencies in their domestic services.(22)

The advent of space communication may provide interested international organizations and their member countries with an opportunity to avoid some of the difficulties experienced in the past in conventional radio services. Space communications are relatively economic in frequency usage and it would appear that protection against harmful interference could be assured through processes of international allocation and assignment of frequencies.

Study of the growing world demand for communication channels and of plans for the expansion of conventional services indicate that, beginning about 1965, these facilities will be overloaded in many areas. An alternative means of communication, such as that offered by space satellites, will need to be developed. It would therefore appear necessary that adequate spectrum space be allocated to the satellite service to meet foreseeable needs up to at least 1975.

In determining the amount of spectrum space required for space communication, provision would need to be made for telegraph relay, facsimile relay, telephone relay, television relay, AM/FM broadcasting and television broadcasting. In addition, frequencies would be required for telemetry, tracking, guidance and other aspects of satellite and space vehicle operation.

International agreement on the allocation of frequencies for space communication is manifestly a first essential. A major problem confronting the 1963 Conference is that the high frequencies in the range 1,000 Mc/s to 10,000 Mc/s, which would be technically suitable for space communication systems, have since 1959 been fully allocated to conventional radio relay systems which play so important a part in international telephone and television traffic. It therefore appears inevitable that this band of frequencies would need to be shared between the two services - space communication and radio relays. International study of the problem has resulted in a recommendation by the Tenth Plenary Assembly of the ITU's International Radio Consultative Committee (CCIR), held at Geneva early in 1963, that frequency sharing between the two services is in fact technically possible and that the grade of service of already established conventional systems will not be materially affected.(23)

At the time of preparation of this report, the only published information on suggestions by Members of the ITU as to frequencies which might be reserved to some degree for space communication concerned preliminary proposals made by the U.S.A. and the USSR. The estimate of the U.S.A. is that 2,975 Mc/s would be needed between 3,700 and 8,400 Mc/s for satellite relays, plus a relatively small allocation for other purposes. In general, the bands would be shared with other radio services. However, because of the much greater difficulty in providing protection against interference

to and from mobile stations, two bands of 50 Mc/s width are proposed for exclusive allocation to space communication.(24)

The estimate of the USSR is that 950 Mc/s between 3,550 and 6,170 Mc/s and 1,500 Mc/s between 28,000 and 29,500 Mc/s (a total of 2,450 Mc/s) should be allocated for space communication.(25)

Except for the bands selected for sharing, the two views are not far apart. However, there is a substantial difference in views on the ease of sharing between communication satellites and the radio relay services concerned.

It may be noted that in many cases these services are operated by countries which, while not yet engaged in space communication, have every prospect of benefiting from its development. Failure to agree, or failure to implement agreed measures could, in the words of the Secretary-General of the ITU, "set space telecommunications back a decade"(26) and result in the same confusion and difficulties as have plagued the development of terrestrial radio services. Concerted international action is needed in this and other fields to bring the benefits of space communication as soon as possible to all countries.

A frequency problem of long-term interest is that of direct sound or television broadcasting to home receivers. The practicability of broadcasts to the general public by relay through national control stations has been demonstrated by the first communication satellites, notably through the Eurovision and Intervision networks. However, the organization of direct broadcasts from satellites raises various technical, administrative and legal issues. Apart from the radio-technical problems in this field, there are those involving international agreement on broadcasting into a State from a satellite not under that State's control. Other problems concern the co-ordination of operations so that interference does not occur.

The ITU, in its second report to the United Nations in April 1963 on "Telecommunication and the Peaceful Uses of Outer Space", commented that "it seems to be very doubtful that such a form of broadcasting would come into being within the foreseeable future". Nevertheless, the 1963 conference might consider that the reopening of the ITU's frequency allocation table for review is a special occasion which should take into account the ultimate possibility of direct broadcasting from satellites.

OPERATIONAL PROBLEMS

Participation in a space communication system would raise a variety of operational problems, some of which would be of particular concern to countries with limited resources.

Access to the system

It is apparent that a prerequisite to the effective development of space communication is freedom of access to its facilities by all countries, both for the sending and receiving of transmission. Stated opinion on this issue has been unanimous.

The General Assembly of the United Nations, in the resolution of 1961 referred to earlier, expressed its belief that outer space should be used "for the benefit of States irrespective of the stage of their economic and scientific development" and that space communication specifically "should be available to the nations of the world as soon as possible on a global and non-discriminatory basis".(27) Subsequently, in 1962, the Administrative Council of the ITU requested all member countries of the Union to participate actively in the forthcoming conference so that the conference would be able to take decisions which might influence space communication development for the benefit of all the world's peoples.(28)

To be economically viable, a global system would in fact need to be founded upon participation by many countries. In this way, its high capacity channels would be fully utilized and operating costs would be reduced. If the pattern of development of conventional communication were to be followed, the degree and character of participation in a world system might vary from country to country.

For example, certain countries might desire to share in the ownership and management of the satellite portion of the system and have a voice in its establishment and management. Other countries might wish to participate through ownership and operation of their own ground stations which would give them access to the system. Other countries, again, might be content to have access to the system through the ground stations of neighbouring countries. And there might be those countries - a diminishing group over the years - which might find that conventional facilities were sufficient to meet their needs for the time being.

Costs and rates

A major problem is the operating cost of a ground station. Annual costs, which will depend on local conditions and the nature of the station, would run at an estimated 25 per cent of the initial investment cost of the terminal. Included in these costs would be provision for skilled operating staff. To support a 24-hour station operated continually, between 20 and 27 persons would be required for administrative, technical and other purposes. Low-capacity stations of the type already described would probably be less costly to operate and require fewer personnel.

One of the questions most widely discussed is the way in which rates for space communication might be established. Under existing procedures, rates for various conventional services are set by the telecommunication administrations or operating agencies concerned. The Telegraph and Telephone Regulations of the ITU set only the maximum allowable rates and specify how the charge for a particular transmission shall be divided among the various administrations or agencies over whose

lines the transmission has passed.

It is obvious that the present structure has given rise to many disparities in rates, particularly in the developing regions and between those regions and other parts of the world. Surveys conducted by Unesco have shown that in these regions, charges made for similar services for the transmission of press messages may vary by as much as 700 per cent. These disparities are largely due to differences in methods of fixing charges, to the vagaries of exchange rates and to the fact that the same charges are frequently made for messages sent by radio, even where no intermediate handling is involved, as for those sent by cable and requiring the payment of extra transit fees to one or more intermediate stations.

It may be noted that while there has been considerable speculation as to the level of rates to be charged for space communication services, no definitive statement on this complex problem has so far been made. For one thing, it is still too early to estimate accurately the operating costs per channel of a satellite system, since only experimental satellites have so far been launched. For another, present conceptions of costs and rates will no doubt be conditioned by the fact that the same satellite will probably be used at the same time for various purposes, such as telecommunication relay and radio navigation.

Nevertheless, there seems to be a widespread belief among authorities in the field that if the capacity of a satellite system was fully utilized and its component satellites remained reliably in service for a sufficiently long time, the impact on communication rates generally would be favourable. The following quoted statements are typical of expert opinion in countries at present engaged in the development or study of space communication.

The Chief of the Office of Satellite Communications, Federal Communications Commission, United States of America, has stated: "It is much too soon to predict what the impact of satellites will be on communication rates, having in mind the technological uncertainties that remain to be resolved. It is, of course, the hope and expectation that satellites will provide channels of communications at a lower cost per channel than conventional cable or radio, which, in turn, should make possible a lowering of rates charged to the public. This does not mean, however, that the rate for a telephone call routed via satellite will be different from a rate for a call routed via cable between the same terminals. Based upon rate-making practices traditionally employed by United States common carriers, we expect that the rates for service between any given pair of points will continue to be the same whether the message is transmitted via high frequency radio, cable or satellite. In other words, as is the case today, rates charged to the public in the United States will in effect be predicated upon an averaging of the cost of all classes of facilities used in furnishing overseas service. The practice to be followed by other countries will, of course, depend upon the rate-making policies of each country".(29)

In the United Kingdom, the Postmaster-General stated recently in Parliament that the increased communication capacity necessary to handle the very rapid growth in international telephoning could probably be handled more cheaply by satellite than by cable, although the two systems would be complementary for many years to come.(30) Meanwhile, a European industrial study group has estimated that a satellite system could provide telephone services at rates some 40 per cent less than the present international tariff.(31)

INTERNATIONAL CO-OPERATION

Solution of the foregoing problems depends to a very great extent on technical co-operation. Telecommunication, by its very nature, calls for co-operation between countries and the promotion of such co-operation has been the concern of the ITU over a period of nearly a century. Since space communication is essentially global in nature, it involves the basic features of international co-operation to an even greater degree.

The importance of international co-operation in this field has been recognized from the outset. At its 16th session in 1961 the General Assembly of the United Nations, on the suggestion of the Committee on the Peaceful Use of Outer Space, adopted a resolution in which it noted with satisfaction that the ITU planned "to call a special conference in 1963 to make allocations of radio frequency bands for outer space activities" and recommended that the ITU "consider at this conference those aspects of space communication in which international co-operation will be required".(32) Subsequently, in 1962, the General Assembly considered the first report of the ITU on "Telecommunication and the Peaceful Uses of Outer Space" and emphasized "the importance of international co-operation to achieve effective satellite communication which will be available on a world-wide basis". The General Assembly also maintained that it was of the utmost importance that the 1963 conference "make allocations of radio frequency bands sufficient to meet expected outer space needs".(33) It may be noted that in its current second report to the United Nations on "Telecommunication and the Peaceful Uses of Outer Space", the ITU observes that the results of the forthcoming conference "are likely to have a very important bearing on the development of space applications of all kinds for the next 10 to 15 years".

International co-operation presents a number of manifest advantages for the development of space communication. Firstly, it provides the framework for the allocation of frequencies which is essential if space transmissions are to be free of interference. Secondly, it facilitates the establishment and use of ground stations and connecting distribution networks. Finally, international

co-operation offers the widest possibilities for helping the developing countries by making available knowledge and techniques to them under the United Nations Expanded Programme of Technical Assistance and other aid programmes.

Facilities of the International Telecommunication Union

Within the ITU, the principal means for international consideration of the technical aspects of frequency allocations is the International Radio Consultative Committee (CCIR). As explained below the Administrative Radio Conference and the International Frequency Registration Board are also concerned with these problems. Responsibility for international review of various other technical communication problems rests with the International Telegraph and Telephone Consultative Committee (CCITT), which is concerned with cables, microwave and landline connexions and, in many regions of the world, with rates charged for services.

Study Group IV of the CCIR is responsible for studies of space communication and radio astronomy. It has been extremely active during the past three years in the preparation of study programmes, reports and recommendations on various phases of planning for the use of communication satellites. At the recent Plenary Assembly of the CCIR, by far the greatest number of documents and volume of interest centred on the study group's work in this area. Another reason for this interest, of course, was the CCIR's specific obligation to advise the forthcoming conference.

Of particular interest to Member States from Unesco's point of view would be those recommendations and reports of the CCIR and the CCITT concerning conditions of establishment of ground stations and the integration of national communications systems with the world-wide conventional telecommunication system and the satellite system now envisaged. Many of the documents resulting from the recent Plenary Assembly of the CCIR deal with these problems.

A joint committee of the CCIR and CCITT has been formed to promote circuit planning of all cables, landlines and radio facilities. Sub-committees of this main committee have also been established to carry out the work for each major region such as Africa, Asia and Latin America. These sub-committees produce circuit lists and maps showing interconnexions among the various international terminals. It would presumably be necessary at some point to incorporate satellite terminals in these plans. Sharing of the use of these terminals would of course be effected by interconnecting the national conventional systems involved with each satellite terminal.

The permanent body of the ITU concerned with the notification and registration of frequencies and the procedures laid down in the Radio Regulations is the International Frequency Registration Board, composed of 11 elected independent members, each of whom is a national of a different member country of the ITU.

One of the Board's duties is the technical planning for Administrative Radio Conferences with a view to reducing their duration. It is also responsible for providing assistance to administrations in the field of radio spectrum utilization, in particular to administrations needing special assistance. Another function is the recommendation to administrations, where appropriate, of adjustments in their frequency assignments, in order to secure a better use of the radio spectrum. Administrations can request the Board to investigate cases of harmful interference in the use of the radio frequency spectrum and to recommend solutions.

In connexion with the duties mentioned above, the Board is collecting data from administrations for analysis and presentation to the 1963 conference at Geneva. In order to ensure that space communication transmissions do not interfere with each other or with terrestrial telecommunication networks, the Board will, it is expected, be required to apply procedures. These procedures, which will be adopted at the 1963 conference, will form the basis on which space communications will be developed. The Board has similarly contributed to the preparation of procedures for FM sound broadcasting and television services in Europe and Africa. Administrations are vitally interested in these efforts which will help in attaining the mutual goal of the ITU and Unesco, namely, an adequate and satisfactory service.

In the studies which the various organs of the ITU may be expected to make following the 1963 conference, there may be areas in which Unesco could assist by advising on possibilities for the use of space communication for information, education and cultural exchange. Unesco would be ready, if desired, to co-operate with the ITU in this manner.

TECHNICAL ASSISTANCE

Coupled with the opportunities for advice and assistance through the organs of the ITU are those offered by technical assistance. The importance of such co-operation has been demonstrated even during the present experimental phase of space communication development. For example, a number of countries, including Brazil, France, the Federal Republic of Germany, Italy and Japan have received technical advice, on a bilateral basis, on the installation and use of ground stations.

Technical assistance is of particular importance to the developing countries both in the establishment of ground stations and in the expansion of domestic distribution networks so that they will be prepared to send and receive space transmissions when these become available. Under the United Nations Expanded Programme of Technical Assistance, the ITU has been designated the executing agency for assistance in development of all forms of telecommunication.

The significance of technical assistance in the development of space communication was recognized by the General Assembly of the United Nations in 1961, when, in adopting its resolution on "International Co-operation in the Peaceful Uses of Outer Space", it invited the Expanded Programme of Technical Assistance and the United Nations Special Fund, in consultation with the ITU, "to give sympathetic consideration to requests from Member States for technical aid and other assistance for the survey of their telecommunication needs and for the development of their domestic communication facilities so that they may make effective use of space communication".(34)

In the case of each developing country or region, planning for the use of space communication obviously presupposes a considerable body of knowledge concerning all the factors involved, both in developing and utilizing a communication system and in giving the communication programme its rightful place in a general programme of economic and social development. In many fields, the knowledge now available is far from sufficient. It is important that research to fill the gaps be pursued as expeditiously as possible by the countries concerned, with such assistance as can be provided by the competent international organizations, individual governments and other interested agencies.

Planning for the best use of space communication by the developing countries is only one of the many areas in which international co-operation will be required if the greatest possible benefits are to be derived from this revolutionary new technique. For if space communication can enable nations as well as individuals to work together in ways that have not been possible before, its functioning will also require new forms of co-operation among them.

FUTURE ACTION

The Administrative Council of the ITU at its 18th session in March-April 1963 decided that the agenda for the forthcoming conference should provide for the allocation of frequencies for space communication and for radio astronomy, for the necessary revisions of the Radio Regulations of 1959 and for the adoption of such additional provisions as are essential to the effective implementation of the conference decisions.(35)

The Administrative Council also considered replies to the request which it had made to Members and Associate Members of the Union(36) that they suggest subjects which they regarded as appropriate for international co-operation in order to achieve the objectives set forth in General Assembly resolution 1721 D(XVI) of 1961. These objectives, specifically, were the availability of space communication "to the nations of the world as soon as possible on a global and non-discriminatory basis", the establishment of effective satellite communication to that end, and the provision of technical assistance to Member States for the development of their domestic communication systems so that they might make effective use of space communication.

Among the replies submitted by Members of the ITU to the Administrative Council were some which contained suggestions going beyond the scope of the provisional agenda for the forthcoming conference.(37) Australia proposed the formulation of plans for the integration of satellite communication links into the international telecommunication network. The Federal Republic of Germany mentioned regulations for direct broadcasts by satellite, and for licences for groups of countries forming supra-national organizations. Japan referred to measures for the international co-ordination of satellite systems and an international guarantee for non-discriminatory participation by all countries in the use of such systems. Sweden suggested operational and financial questions concerning space communication services, technical assistance for participation in space communication, legal problems, and requirements of the United Nations and certain of the Specialized Agencies.

Similarly, the United Kingdom listed the arrangements to be made for the interconnexion of satellite systems and national or international networks; for the setting up of a satellite system, taking into account the need for access to satellites by numbers of low and high capacity ground stations, the traffic capacities to be provided and the form of the system to be used; and for the planning, construction and ownership of a system, its control, management and financing, the provision of ground stations and the sharing of their use.

Subjects proposed by the U.S.A. were the establishment of ground stations; the gathering of statistics on international telecommunication traffic and reliable estimates of anticipated traffic volume; consideration of international telecommunication rates in the light of the impact of satellite communications; and the nature and extent of planning required for new and expanded cable, radio and satellite communication facilities so as to derive maximum benefit from each of these modes of communication.

The Secretary-General of the ITU, in commenting on the above replies, observed in his report to the Administrative Council that "even if it is thought that the whole range of aspects referred to in the General Assembly resolution might be more suitably examined by a later conference, it should also be realized that events in space communications are now proceeding with such speed that preparatory consideration of all those aspects at an international level needs to be initiated as soon as possible". Such preparation, the Secretary-General suggested, might lead to the convening of an ITU world conference on the general aspects of space communication.(38)

CHAPTER III

APPLICATION THROUGH THE MASS MEDIA

It is evident that telecommunication is the key to all activities in outer space, not only for communication through the mass media, but also for space research, space travel, meteorology, navigation and other purposes. Telecommunication is indispensable for the command and tracking of satellites and space-probes, for the telemetering to earth of research and other information gained in spacecraft and for the vital links between manned spacecraft and their controlling ground stations.

Setting aside the multiple aspects of the uses of space communication which are not germane to the present report, an examination may be made of space communication in the light of its effectiveness in enhancing the range and scope of the mass media of press, radio broadcasting and television. This examination will deal in the main with the rôle of space communication during the anticipated initial period of its use, when facilities for telephone and telegraph services and for relayed radio and television broadcasts would be made available. An assessment will be made according to the media - press, radio and television - through which space transmissions would be channelled.

CHANNELS FOR SPACE COMMUNICATION

Press

For economic and technical reasons, it seems likely that space communication will first be used regularly to provide long distance telegraph and telephone services for the press and other commercial users. As the first communication satellites were being developed and tested, their potentialities were being studied with cautious but optimistic anticipation by news agency executives as well as by newspaper publishers.

Press interest in these potentialities had already been stimulated by the successful initial relay, in mid-1962, of world news agency dispatches by satellite between Europe and North America. London and New York newspapers had also exchanged dispatches by this means.

While predictions varied as to the date when a satellite service would be available for world-wide transmission of news and photographs, news agency experts pointed out that the extent of news agency participation in the initial stages would be determined by several factors other than simple availability.

In the first place, much would depend upon whether the service were provided by synchronous or non-synchronous satellites. If non-synchronous satellites were used, news agencies could have no direct rôle in their use. Many satellites would be involved in a non-synchronous system operating at low or medium altitudes ranging from 300 to 12,000 miles. Transmitting and receiving facilities would have to be capable of tracking each of the fast-moving satellites as it became "visible" over sending and receiving points for brief periods. Only commercial and governmental organizations would be able to underwrite the expense of such facilities. News agencies could only lease channels - assuming reasonable cost - as they now lease land lines.

However, spokesmen for the agencies agreed that they would welcome even this system, because it would expand greatly the limited number of radio communications channels available around the globe and would improve the quality of these services.

Technicians were far more interested in the possible use of synchronous high altitude satellites. Such satellites would not only make available the same number of radio frequency channels as would non-synchronous satellites, but they would permit the use of much simpler and less expensive receivers on the ground. Presumably, newspapers subscribing to the agency's services could install and maintain these receivers as they do now to receive messages transmitted by terrestrial means.

It was pointed out, however, that such direct reception by newspapers might not be possible at first even if synchronous satellites were used. Because of the difficulty of launching a heavy satellite into an orbit as high as 22,300 miles, the first few units are expected to carry only low-power transmitters. In this case, ground receiving stations would probably have to be ultra-sensitive, employing parametric or maser amplifiers. While the cost of these receivers is much less than that of receiving systems necessary for tracking and receiving signals from non-synchronous satellites, it is still much too costly for general use at all news agency subscriber reception centres around the world.

The experts considered it conceivable that a few major news agency reception points might be equipped with these expensive receivers and antennas to take immediate advantage of the new facility and gain experience with its use. But they believed that the real expansion of the new system, so far as news agencies were concerned, would probably not occur until large synchronous satellites carrying comparatively high-powered transmitters were

put into orbit. Then the receiver requirements would become much less severe, and the cost of receiving equipment would probably no longer be a critical factor. They were ready to predict that, from then on, the reception of news agency radiophotographs and news by satellite would spread rapidly around the globe.

News agency experts pointed out that the use of space communication for the collection and distribution of news and pictures would have two advantages over the radio communication system now employed. First, as already noted, communications between various news agency bureaux and newspaper subscribers in all parts of the world would be made easier and more reliable. Second, to the developing countries, especially in regions such as Asia and Africa where distances are great and communication facilities very limited, space communication would bring their first completely dependable contact with the rest of the world.

For the transmission of news and pictures generally, a successful satellite communication system would be significant in two ways. For one thing, it would provide additional high quality commercial communication channels for possible use in point-to-point transmission of news and pictures. (While facilities for this particular type of service are adequate at present, this condition will not hold indefinitely, and a reserve source of facilities for possible future needs would be helpful.) In addition, such a system would provide improved area-wide and world-wide reception of news and pictures in comparison with the present method.

Present methods of transmitting and receiving by high frequency radio have a number of shortcomings. One of these is erratic fading of the radio signal in high frequency communication over long distances. This can reduce the quality of reception, or interrupt it completely, at unpredictable times. Another is the need for changing frequencies for reception according to the time of day, the season, and even the sunspot cycle.

For the high frequency service, every morning and evening, difficult transition periods occur when the best reception frequency changes, usually very rapidly, from a low to a high frequency or vice-versa. In addition, frequencies must be changed at other times during each twenty-four-hour period because the optimum frequency varies gradually from hour to hour. As a general rule, this pattern is repetitive from day to day over a period of several months, but seasonal corrections have to be made several times a year. Finally, the eleven-year sunspot cycle has a strong effect on radio communications. During a three-or-four-year period of minimum sunspot activity in each cycle, the higher frequencies of the H.F. bands become less useful than at other times for communication purposes, and all the world's radio communications must be squeezed into the lower frequency bands. This increases interference between different services.

In order to minimize these various obstacles to clear and regular reception, complicated and expensive precautions must be taken. One precaution is to use two or more frequencies simultaneously to transmit the same information, either to increase reliability during difficult periods or for other reasons. As reception points relatively close to a transmitter require a lower frequency than points much further away, the use of more than one frequency is often necessary when transmitting simultaneously to widely separated points.

Another palliatory measure is diversity reception, which is the use of two separate radio receivers fed by separate antennas spaced an appreciable distance apart. This practice is based on the theory that as a fading signal becomes weaker at one antenna it will become stronger at the other. The cost of receiving equipment is practically doubled under this system, but it is considered essential for the reception of news.

News agency technicians believe that all these shortcomings will be eliminated or reduced by the use of satellites. Transition periods will not exist, because every frequency assigned for satellite use will be practically as good as any other, and this will hold true 24 hours a day all year round. Thus the troublesome changing of frequencies several times a day at both transmitting and receiving points will be eliminated. This will permit, in essence, fully automatic, unattended reception. It will also make the use of more than one frequency unnecessary, thus saving on the cost of extra channels, and permitting those channels to be used for other services.

The eleven-year sunspot cycle is not expected to have any effect on signal strength at any frequency proposed for use in satellite communication. Diversity reception will probably no longer be necessary, since fading is expected to be almost non-existent. The elimination of fading will be a boon in several ways. It will improve radiophoto reception, which at present, for technical reasons, cannot enjoy the benefits of diversity reception. For radioteletype reception, it should make a second antenna and radio receiver unnecessary. The problem of finding space for the double antenna system would thus be simplified and costs would be reduced.

The possibility of solving so many problems, most of them serious and costly, is considered reason enough for any news agency with international interests or contacts to look forward hopefully to the successful establishment of space communication.

The special significance of space communication for news services in the developing countries has been noted both by representatives of world news agencies and by spokesmen for the press in the developing countries themselves. African news agency experts participating in a meeting on development of news agencies in Africa, convened by Unesco in Tunis in April 1963, urged governments of the region to "give due consideration, in their plans for the integration of national telecommunication networks, to the possibilities which are likely to

be offered in the not too distant future by space communication", and to ensure that, when space communication services are established, facilities be included "for the transmission of press messages within Africa and between Africa and other regions of the world".(39)

At present most of the developing countries have very few facilities for communicating with each other or with the rest of the globe. News agencies are gradually establishing radioteletype and radiophoto reception points wherever feasible, and taking advantage of commercial radio transmitting and wire line facilities for transmission of news and pictures wherever these facilities are available. Agency experts believe that this trend is bound to continue whether radio communication remains in its present state or leaps ahead suddenly into the space age, but that it will be greatly accelerated when commercial service via satellites is established.

In its early stages, as at present, the transmission of news and pictures would need to be done on a contract basis by governmental or commercial telecommunication agencies, which are able to spread the large cost of transmitting facilities over many subscriber services. Reception, on the other hand, is now handled to a large extent by the news agencies themselves and their subscriber newspapers, as the costs involved are much lower and the flexibility provided by the ability to set up reception points wherever required is of great advantage. To be of greatest value to news agencies, satellite communications would have to provide the same flexibility - which means primarily that the cost of the necessary receiving equipment could not be much higher than at present.

Will such be the case? As of mid-1963, news agency experts were not yet able to predict the answer to this key question, which will of course have an important bearing on the rapidity with which news agencies can expand their coverage in the developing countries, as well as elsewhere. While they knew that many of the component factors of the overall cost would be smaller (due to elimination of the use of more than one frequency and diversity reception), they were obliged to recognize the fact that other costs might be higher. They hoped, however, that the overall cost would be comparable with present costs.

It is apparent that users of space communications will enjoy many advantages. Better services with higher quality and reliability will be provided, reception at long distances will be facilitated and costs may be reduced. As already noted, however, the provision of space communication services will involve considerable expense for some time due to the cost of the satellites themselves as well as of ground stations and linking terrestrial networks.

In so far as they depend on news agencies for their world news, newspapers may be expected to benefit from space communication to the same extent as news agencies. This prospect has already engaged the attention of professional organizations of the press. The International Federation of Newspaper Publishers and the Commonwealth Press Union, to cite but two examples, have dealt with the issue at their conferences. Space communication is also of special interest to the comparatively few major newspapers which maintain their own correspondents abroad: these correspondents should logically have open to them satellite channels reserved for press dispatches. If space communication should prove to be less costly than communication by present means or bring about a general reduction in press rates, editors would be encouraged to ask for wider coverage of world news and thus to have a broader selection of material from which to select news reports for presentation to their readers.

It has also been suggested that, by the time a space communication system is working, journalists might have available to them small machines, roughly the size of portable typewriters, on which they could record their news reports on paper or magnetic tape; this tape would be utilized for retransmission in much the same way as teletypewriter tape is now utilized. The use of such tape might considerably speed up transmissions, thus adding to the news-carrying efficiency of the satellite system and therefore to its value where both news agencies and newspapers are concerned.

There is a second way in which space communication may well be of vital importance to newspapers: for the distribution, rather than the collection, of news.

Up to recent times, a newspaper, no matter what its size or importance, was essentially a local enterprise, printing all its editions in one spot, from which they were distributed in the city of publication or further afield. Within the present century, however, and especially since the end of World War II, there has been an increasing tendency among major newspapers to issue editions in more than one city, sometimes in more than one country. In order for editions to be issued simultaneously, or almost simultaneously, at widely separated points, dependable high-speed transmission facilities, such as facsimile and teletype-setting, are a vital necessity.

In mid-1962, a United States newspaper, which publishes editions in New York and Paris, carried out an experiment which showed that this type of service can be performed through space communication. The newspaper transmitted several articles from New York to its edition in Paris through a communication satellite, as well as whole pages to and from the satellite. Simultaneously, the newspaper sent the same information from New York to Paris via conventional communications channels. While some of the information sent by conventional means was received garbled in Paris, the information sent by satellite was received without errors.

The advent of space communication may therefore be expected to accelerate the current trend towards newspaper expansion and make possible the simultaneous publication of newspaper editions or

features in several countries or throughout whole regions. With vastly increased and dependable communication facilities available, newspapers may be able to expand, nationally and internationally, on a scale that has not been possible before.

Radio broadcasting and television

The success of the experimental television relays which have recently been conducted by satellite in both directions across the Atlantic has impressively demonstrated the potentialities of this medium for the world-wide exchange of live television programmes. There is no doubt that such exchanges could greatly widen the range from which live programme material could be drawn. When satellite systems provide regularly available television links between continents, they will open up a rich field from which the television services of all countries could benefit.

Space communication also has significant implications for radio broadcasting. The sound component of a television programme can be transmitted along with the vision component and there appears to be no technical reason why radio as well as television programmes should not be exchanged by satellite. This is an important consideration, particularly for the developing countries. For, although space satellites are popularly associated with television, it should not be forgotten that many areas of the world cannot yet receive reliable, good quality sound. The advent of space communication, coupled with the timely development of low-cost transistorized receivers, which could be used to pick up satellite transmissions relayed by local stations, might give a great stimulus to clearer, more reliable radio broadcasting.

At the same time, it should be recognized that the use of space communication through the broadcasting media raises more numerous and more complex problems than does its use through the press. Recent conferences of professional organizations of broadcasters, such as the European Broadcasting Union and the International Broadcasting and Television Organization, have in fact been considerably concerned with the technical, programming, economic and legal problems of space communication.

Both for radio and for television, a satellite system could be used in three possible ways. The first, as illustrated in the recent trans-Atlantic tests, is to relay live programmes over long distances for exchange between countries in different parts of the world for retransmission by local stations in the receiving country. In this case the satellite system provides a point-to-point link between the broadcasting organizations of two countries or of two continents.

The second possibility is to carry programmes from one country direct to listeners and viewers in another country. As already observed, this form of broadcasting raises a number of technical and other problems and does not show promise of realization until further technological development has been achieved. The third possibility is the use of a synchronous satellite as a means of extending the coverage of a single station over the whole of a large country or over a group of adjacent countries. This possibility also awaits a further breakthrough in technological development.

It is the first possible use of a satellite system - that is, the relay of programmes for local distribution - which is mainly dealt with here. This is already an accomplished fact, though on a relatively modest scale.

The future use of space communication will depend on its viability as against other methods of transmission. In the field of radio, existing methods of broadcasting provide a relatively simple means of achieving national coverage. The exchange of live programmes between countries throughout the world can also be carried out by conventional means - land-lines, submarine cables, microwave systems, point-to-point high frequency links, and direct reception of high frequency (short-wave) broadcasts. Reception by these means is, however, in many instances far from perfect.

For those radio programmes in which there is no element of topicality or suspense, international exchange can also be carried out effectively by means of recordings on magnetic tape. Satellite systems, however, can carry a large number of sound channels simultaneously and it is possible that the use of such channels for carrying radio programmes would be economic if, for example, the channels were employed at a time when other traffic is light.

In that event, programmes could be broadcast once for all interested receivers, thus eliminating the need for making "x" number of tapes for distribution. Language barriers could to a considerable extent be overcome if there were local translators at ground stations to "dub in" the appropriate language. Educational and other institutions on a global scale could then tape broadcasts and build up extensive and varied radio libraries.

For television, space communication perhaps holds greater promise, due largely to the fact that there are important routes over which no alternative method is yet available for the transmission of live programmes. Because of the relatively wide frequency band required, and the propagation characteristics of the frequencies used, television transmission across oceans cannot be achieved over high-frequency radio links and the use of microwave links would require a number of intermediate stations carried by ships or aircraft, or installed on conveniently located islands. Submarine cables could no doubt be developed for television transmission over long distances but would be costly because of the bandwidth required. Methods have been proposed for compressing the bandwidth of a television signal, but so far none has proved worth while.

In the field of television, in short, satellites open up a new era by affording faster communication

over long distances than has ever previously been possible. Through the international exchange of live programmes, viewers are enabled to see far-off events as they happen and when they happen. The implications of this technological breakthrough, particularly for television journalism, are manifold.

Certain of the purely technical problems of television exchanges via satellites have already been solved. The technical quality of the received pictures has been remarkably high. Many of those exchanges across the Atlantic were free from fading, of good definition and contrast, and had a low level of noise. Successful experiments have been made in the transmission of pictures in colour, which demand a very high standard of technical performance.

As already noted, ground stations must be accessible to existing national and international networks. In North America and Europe, connexions have already been established between them. For example, the existence of the Eurovision network in Western Europe and the Intervision network in Eastern Europe makes possible the dissemination of programmes at any of the European ground stations over almost the whole continent. The organization of such relays, however, demands considerable care and can be complex, particularly if sound commentaries in different languages have to be combined with the visual element.

A further difficulty is that nearly all television services in Europe and Africa use the 625-line/50 field standard, whereas the 525-line/60 field standard is established in most countries of the Americas and in some Asian countries. Consequently, standards converters must be used for live relays between one system and another. This applies also to programmes exchanged on magnetic tape. In the United Kingdom the 405-line/50-field system is in use (though it will ultimately be replaced by 625 lines), and in France, Belgium and a few other countries the 819-line system is used.

Standards conversion unavoidably involves some degradation in picture quality, especially in cases where there is a difference in field rate as well as the number of lines. Existing converters are sufficiently good for programme exchanges and further improvements may be expected. No method of conversion has, however, yet been developed for colour television.

So far satellites have been made available for television exchanges on an experimental basis and for short periods of time. The available period in each orbit varies from about 10 to 100 minutes. The use of satellite facilities on a large scale would require that circuits be regularly available over the principal routes and at reasonable rates.

The use of satellite systems for the exchange of television programmes is obviously of special value for topical items and those in which there is an element of suspense. It is therefore in the field of news, public events and sport that space communication can provide a particularly valuable enrichment of programmes. It is the visual presentation that is most important, especially since language differences will often necessitate the translation of the spoken word. Since the time element is vital, the use of non-synchronous satellites that are available for only a short time in each orbit presents difficulties and particularly so if the route is such that two hops are required. Synchronous satellites would have an important advantage in this respect.

Live television via satellite, it may be expected, will be most frequently used to cover the great "human events" - a summit meeting, a space flight, a coronation or the Olympic Games. Within limits, neither time nor money will matter, for the essence of such events is immediacy. For more routine news, satellites will be used in a more routine way. For example, news cameramen will film a meeting between two European statesmen in Paris. The Paris correspondents for the U.S. broadcasting networks will narrate the film, add other background information and transmit the material by satellite to the newsrooms of the networks in New York. World news, in other words, will be covered ordinarily just as domestic news has been covered, except that a new dimension will be added. Until now, it has been almost impossible to transmit films of events taking place in the afternoon in Western Europe to New York in time for evening newscasts in North America. Television news, in its coverage of overseas events happening late in the day, has been scarcely different from radio news, except for the projection of the image of the commentator reading it. This need no longer be so. The most significant contribution of space communication in this field may be simply to enable television journalism to be more visual.

In cases where neither topicality nor suspense is a vital element, the exchange of recordings on magnetic tape or on film would usually fill the need. Such recordings can be flown by jet aircraft to almost any part of the world within 24 hours. The question of timing is important in relation to time differences (i.e. in the case of east-west or west-east communication) and peak viewing hours in the receiving country. Unless a news item is of quite exceptional importance, it would be sufficient for it to be shown to domestic viewers on the evening of the day when it occurs. There would be little justification for using satellite services if the programme in question has to be recorded in the receiving country for subsequent use at a convenient viewing period in circumstances where a film or tape could be made available in time.

Unless the circumstances are such as to introduce an element of topicality, entertainment and instructional programmes (such as documentaries, variety, drama, opera, ballet and educational or cultural transmissions generally) could be exchanged in recorded form. On the other hand, it should be noted that as in the case of radio programmes, satellite communication could be used to distribute such programmes simultaneously to a number of broadcasting organizations, thus reducing the

number of tapes or films required for distribution. Both means of high-speed transmission would facilitate the establishment of television libraries by educational and other institutions.

The effective development of television exchanges, whether by satellite or other means, will of course depend very largely on the availability of receivers for home or community use. There is a particular need in the developing countries for receivers which could be used in non-electrified areas. Some progress has been made in the production of battery-operated transistor sets and experiments are now being conducted in the development of receivers which would use other sources of power.

An expert from the United Kingdom has meanwhile suggested that it would be technically possible to develop a compromise between radio and full-scale television reception. The new facility would consist of a low-cost and simple slow-scan facsimile-plus-sound receiver which would operate on the normal radio bandwidth, without requiring the approximately 1000-fold spectrum space needed by television. Such a device could reproduce line-drawings and cartoons at an adequate speed for educational purposes, where the same picture has to stay in view for a minute or two. It would be the remote equivalent of the teacher's blackboard and would make possible the teaching of languages to people who did not know their instructor's tongue. By this means, it is suggested, it would be possible to tape programmes suitable for classes distributed over a wide region.(40)

If direct broadcasting from satellites to viewers and listeners should prove feasible, a new range of possibilities both for national and international broadcasting would in certain cases be opened up. Here again, time differences and language differences would present problems. The entire prospect of direct broadcasting remains one of the most speculative aspects of space transmission. However, if the numerous technical and other problems affecting direct broadcasting could be solved, it might be possible to envisage the day when viewers would have a choice not only among half-a-dozen national or local television programmes but, as they now have in the field of high-frequency radio broadcasting, among stations throughout the world. The great advantage of direct broadcasting would be that a single transmission could reach a vast audience over a wide area.

Space communication has raised many programming problems to which broadcasters are now giving considerable study. As indicated earlier, the most immediate use of satellites is for international newscasts and it is this aspect which has captured first attention. It is clear from the essentially global nature of space communication that the trend towards co-operation between broadcasting organizations in many countries will be accentuated by this new technique.

Many of the issues raised by space communication are an extension of the problems encountered in programming through conventional channels. Thus, in the fields of copyright and performers' rights, it has given a new dimension to legal problems which for a number of years have preoccupied radio and television organizations. The new factor is that relays or re-emissions are made from satellites in space which are outside territorial limits.

In the field of copyright, it would at least be clear that if the original emission(s) and the post-satellite re-emission(s) and the final destination(s) were all in areas in States bound by an international copyright system such as the Unesco-sponsored Universal Copyright Convention or the Berne Union, adequate and orderly protection would normally be assured without reference to the satellite emission. Short of these circumstances, there are so many possible combinations that could bear on protection, including the possibility of reference to the satellite emission, that no general rules can be laid down.

The question of performers' rights is even more complex. The Unesco-sponsored "International Convention for the Protection of Performers, Producers of Phonograms and Broadcasting Organizations" (Rome Convention) of 1961 attempts to regulate performers' rights on a world-wide basis. However, even if the Rome Convention were in force between all the States bound by an international copyright system, there would appear to be problems of the application of the convention, bearing on satellite emissions, which would need to be studied by the Intergovernmental Committee to be set up under the Convention.

Other fields

It is apparent that the development of space communication will open the way to applications for the world-wide flow of information which are not necessarily linked to the press, radio broadcasting and television.

Among significant examples is the use of space communication in the processing, classifying and transmission of data. It may thus help to make more readily available in usable form the vast store of knowledge which has resulted particularly from recent advances in science and technology. This application is all the more likely since the high-speed transmission of data by satellite will in many cases require only radio or telephone bandwidths.

Digital data has already been transmitted by satellite between computers in North America and Europe at a speed of 3,300 words a minute and the possibilities of installing tele-computer systems throughout Europe, linked to national telephone networks, are now being explored. The immediate possibilities of applying data transmission in the fields of science and technology have been illustrated by recent satellite experiments such as the broadcasting of weather maps for international forecasts and the dispatch of medical data between continents.

In time, satellites might be used with domestic telephone networks, computers and other facilities to provide a world-wide data transmission service

for scholars, scientists, governments and educational, scientific and cultural institutions. Such a service could not only tap contemporary sources of information but also help to make available the accumulated knowledge of the past through the dispatch of microfilm copies of books between libraries in different regions. Since it is now possible to store any written material or any illustration in electronic form such as video tape, the service might ultimately provide for the establishment of central electronic libraries in each region as part of the world communications network. Readers or scholars would thus be able to call for any document and see it flashed via satellite on their television screens.

Space communication is likely to have unpredictable and ultimately astonishing effects on person-to-person communication generally. For example, it may accelerate the growing tendency of our time to develop contact between people from different countries for the discussion and solution of common problems and the exchange of information. Thus, when adequate facilities have become available and costs are sufficiently low, satellites could be used for international conferences and seminars in which the participants would confer with each other by means of closed-circuit television.

CONCLUSIONS AND SUGGESTIONS

It is evident from the foregoing report that space communication has significant long-term implications for the promotion of Unesco's aims. The report embodies a number of conclusions and suggestions which are summarized below.

1. Space communication is evolving at a time when there is a world-wide need for the expansion of telecommunication to transmit a greater volume of words and images over greater distances. It is apparent that, even at its present incipient phase, this new technique contributes to the development of telecommunication as a whole and that it will do so to an increasing extent. It will ultimately provide links for new global communication systems.

2. Space communication is a technique which enlarges the range and scope of the press, radio broadcasting and television and which, as it develops, will enhance the rôle of these mass media in the dissemination of information, the rapid spread of education, and cultural exchange.

3. In its application specifically through the mass media, it seems likely that space communication will first be used regularly for the intercontinental transmission of press messages and for radio and television relay of events of world interest. Even these initial uses of space communication, by providing a long-distance link between peoples, can help increase mutual knowledge and understanding.

4. As part of a growing trend to use new techniques of communication for more than purely information purposes, space communication may in the long run help in promoting the spread of education. For the developing countries it may be of service in the years ahead in their programmes for rapid progress in education and will also be a means of bringing them into closer contact with other parts of the world, as well as with each other.

5. Programming for space communication will present complex problems which even at the present early stage might be studied by broadcasting services in co-operation with interested organizations, including those in the educational field.

6. A first essential in the development of space communication services is the allocation of frequency bands at the Extraordinary Administrative Radio Conference on Space Communications being held at Geneva in October 1963. The allocation should take due account of the long term frequency requirements of the mass media, together with other communication services.

7. It is anticipated that, as a sequel to the forthcoming Geneva conference, technical studies of the application of space communication will be made under the auspices of the competent organs of the International Telecommunication Union. Such studies might examine the measures necessary to assure technical compatibility among radio and television programme relay facilities in different countries. Unesco would be prepared to assist in these studies in its fields of competence.

8. As the General Assembly of the United Nations and the General Conference of Unesco have affirmed, international co-operation is essential for the solution of many of the problems posed in developing space communication. These problems might usefully be studied at an intergovernmental conference which could in due course be convened subsequent to the 1963 meeting, as suggested by the Secretary-General of the ITU, to review the more general aspects of the development of space communication. In view of the many features of interest to Unesco, as evidenced in the foregoing report, the Organization would wish to be closely associated with such a conference.

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